Perspectives from Sustainability Science about Energy Sustainability

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What I Propose to Do Are to:

First, review the origins and perspectives of "sustainability science"

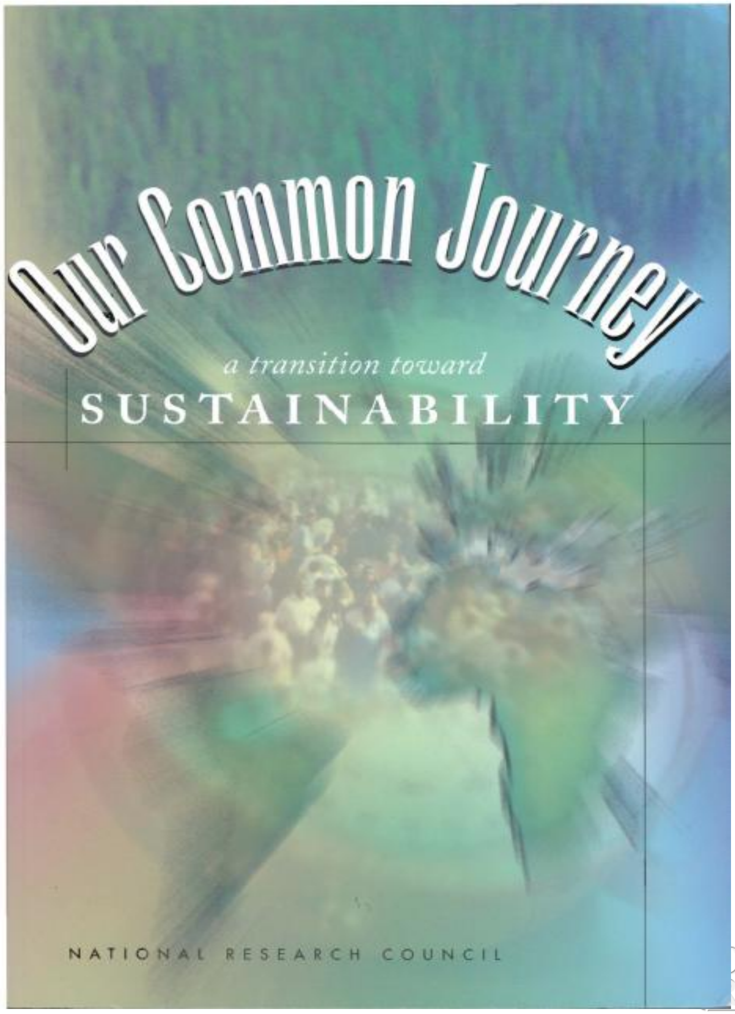
Then, summarize some of the themes that emerge when these perspectives are applied to issues of energy sustainability

Sustainability/Sustainable Development Has Been an Explicit Global Concern for a Quarter of a Century (I):

- **Generally traced back to the "Brundtland Report:"**
  - Commissioned by the UN in 1983 and delivered in 1987, responding to a request for advice about environmental strategies for achieving sustainable development
  - Particular attention to limitations of existing technologies and institutions for meeting current and future needs
- **Followed by the 1992 UN Conference on Environment and Development in Rio:**
  - Aiming to develop principles to guide sustainable development
  - Led to a number of international environmental "conventions:" climate change, biodiversity, desertification, and others
- **And later by the "Earth Summit" on Sustainable Development, Johannesburg, 2002 ("Rio + 10)**

Sustainability/Sustainable Development Has Been an Explicit Global Concern for a Quarter of a Century (II):

- **Followed up in this country by NAS, through a pathbreaking report in 1999: *Our Common Journey – A Transition to Sustainability*:**
  - **Asked: How can basic needs of a global population at least half again as large as present be met in 50 years without undermining environmental services on which development depends in the longer run?**



Sustainability/Sustainable Development Has Been an Explicit Global Concern for a Quarter of a Century (III):

- **Followed up in this country by NAS, through a pathbreaking report in 1999: *Our Common Journey – A Transition to Sustainability*:**
  - **Sketched a future in which sustainability is possible – but only with significant advances in basic knowledge, in the social capacity and technological capabilities to utilize it, and in the political will to turn this knowledge and know-how into action.**

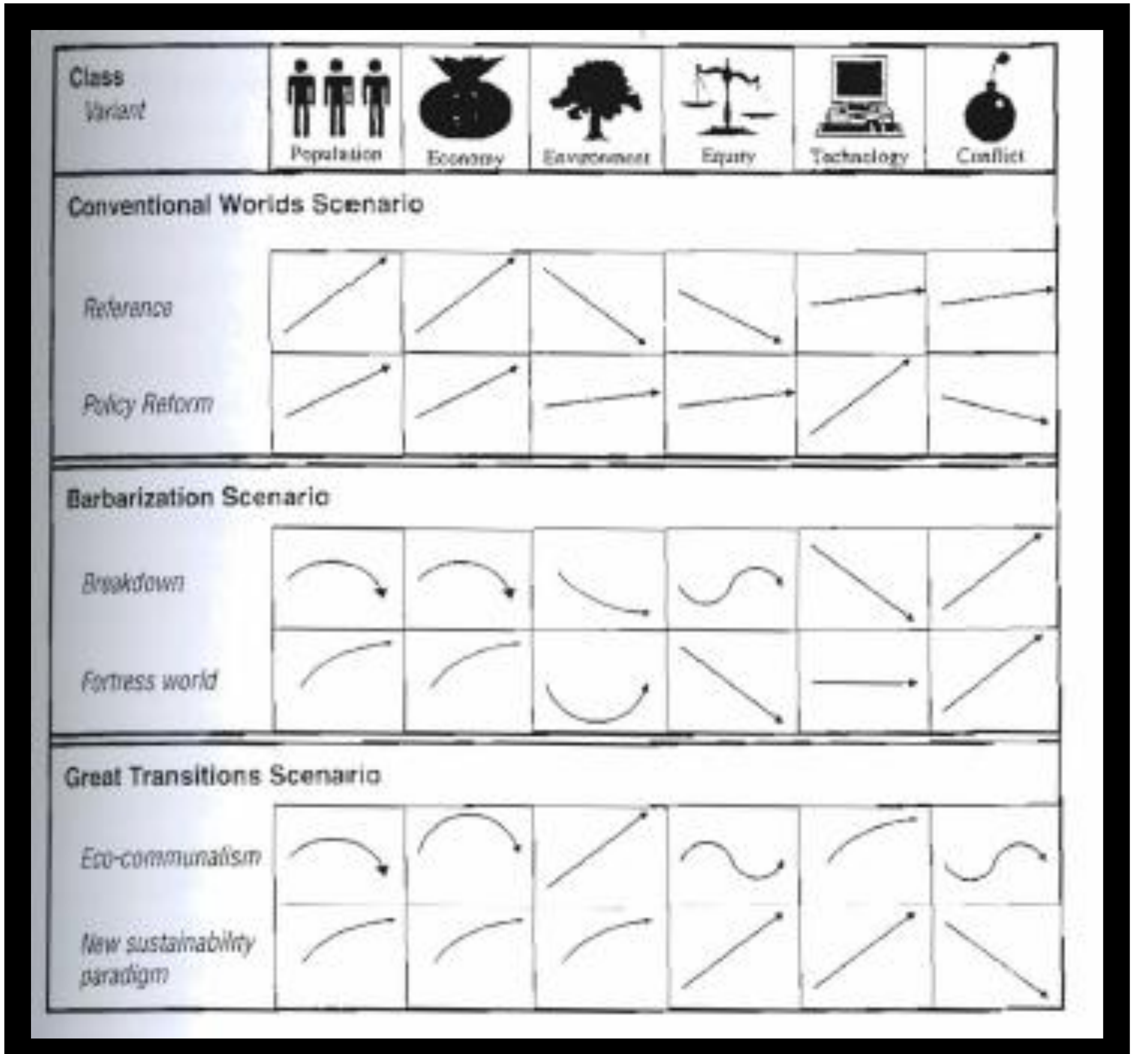
WHAT IS TO BE SUSTAINED:	**FOR HOW LONG?** 25 years "Now and in the Future" Forever	**WHAT IS TO BE DEVELOPED:**
NATURE Earth Biodiversity Ecosystems		**PEOPLE** Child Survival Life Expectancy Education Equity Equal Opportunity
LIFE SUPPORT Ecosystem Services Resources Environment	**LINKED BY:** Only Mostly But And Or	**ECONOMY** Wealth Production Sectors Consumption
COMMUNITY Cultures Groups Places		**SOCIETY** Institutions Social Capital States Regions

Sustainability/Sustainable Development Has Been an Explicit Global Concern for a Quarter of a Century (IV):

- **The NAS report identified five challenges to action:**
  - Stabilizing global population through voluntary actions
  - Accommodating massive urban growth in a sustainable manner
  - Increasing energy and materials services while reducing environmental impacts
  - Restoring degraded ecosystems while conserving biodiversity
  - Reversing declining food production in Africa while sustaining trends elsewhere
- **This effort stimulated the development of:**
  - An NAS Roundtable on S&T for Sustainability
  - A AAAS Center for Science, Technology, and Sustainability
  - Development of the quasi-discipline of "sustainability science," including major university centers at Arizona State and Harvard (see Kates et al., Science, 2001)
  - Most recently, an on-line "Reader in Sustainability Science and Technology" (http://tinurl.com/sustsci-reader)

Sustainability Science Is Associated with a Distinctive View of the Challenge Both to Knowledge and to Action (I):

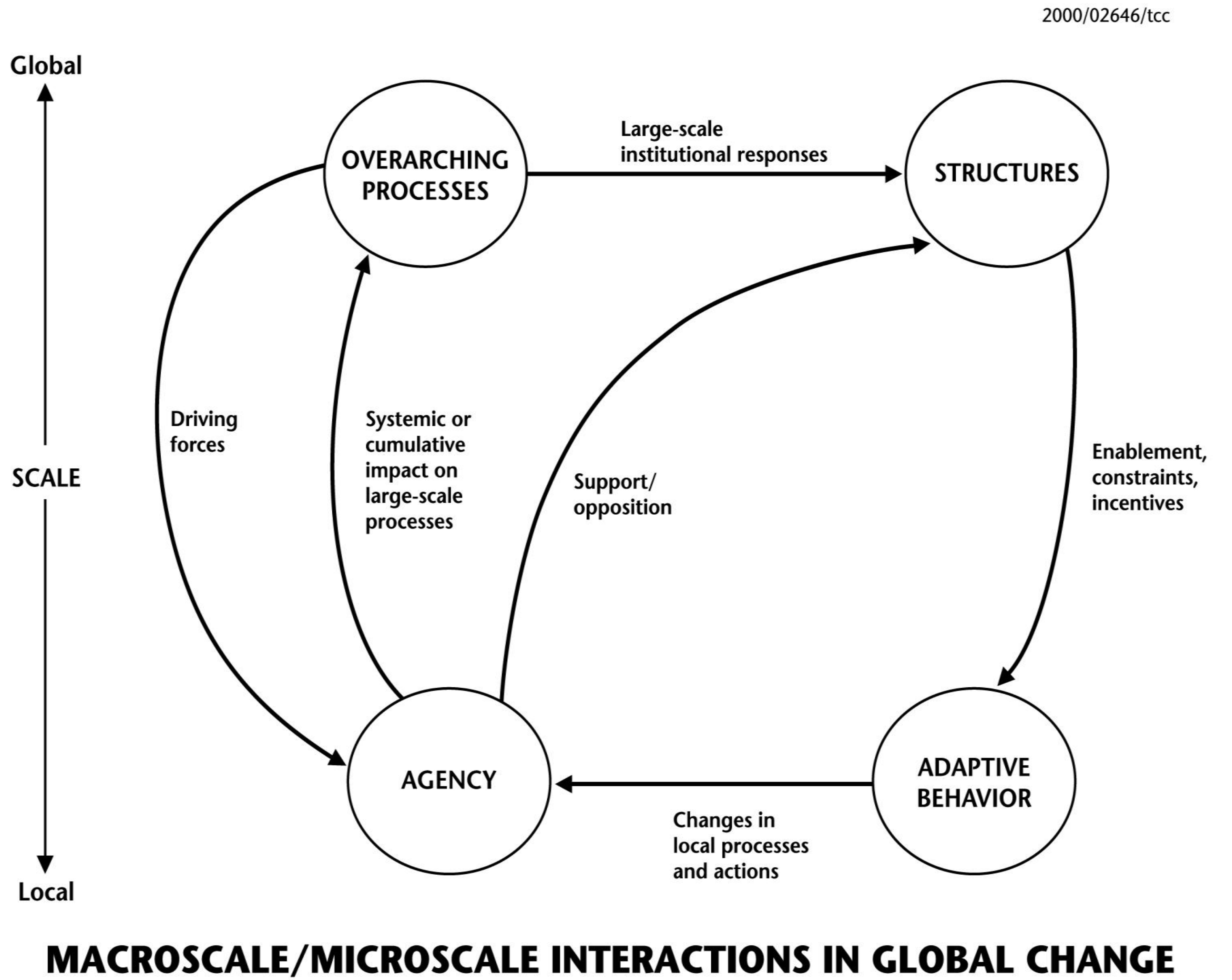
- **The general perspective is that if continued human progress is going to be possible, including closing gaps between the rich and the poor, development must find pathways that both:**
  - **Achieve continuing economic and social progress, without major sacrifices by the privileged**
  - **Find a sustainable balance with a physical environment that is already under stress**
- **Must be done through political strategies that are equitable between nations and regions now and between current actions and the needs of future generation**
- **Particular challenges with such nature/society linkages as food, energy services, materials, job creation, and education**
- **One of the great challenges of our time, where smart people need to find pathways that will both get the job done and *also be palatable to democratic political processes across different sorts of interests***


Class
Variant
Population
Economy
Environment
Equity
Technology
Conflict
Conventional Worlds Scenario
Reference
Policy Reform
Barbarization Scenario
Breakdown
Fortress world
Great Transitions Scenario
Eco-communalism
New sustainability paradigm

Over the Years, We Have Learned Some Things about Sustainable Development, Although Progress Has Been Elusive; for Example:

- **Sustainability is a *trajectory*, not a state**
- **Sustainability is rooted in complexities such as:**
  - **Values, especially potentials for the spread of an "environmental ethic", as contrasted with a consumption ethic**
  - **Linkages and flows – potentials and limitations of system connections (e.g., 2010 MIT Press book on *Linkages of Sustainability*)**
  - **Diversity of contexts – by scale, sector, and parts of the population, e.g.:**
    - **The Millennium Ecosystem Assessment (2005)**
    - **Adapting to climate change (NAS ACC, 2010)**
- **Sustainability can take the form of multiple pathways, each associated with winners and losers: who decides?**
- **Sustainability involves interactions between different scales**

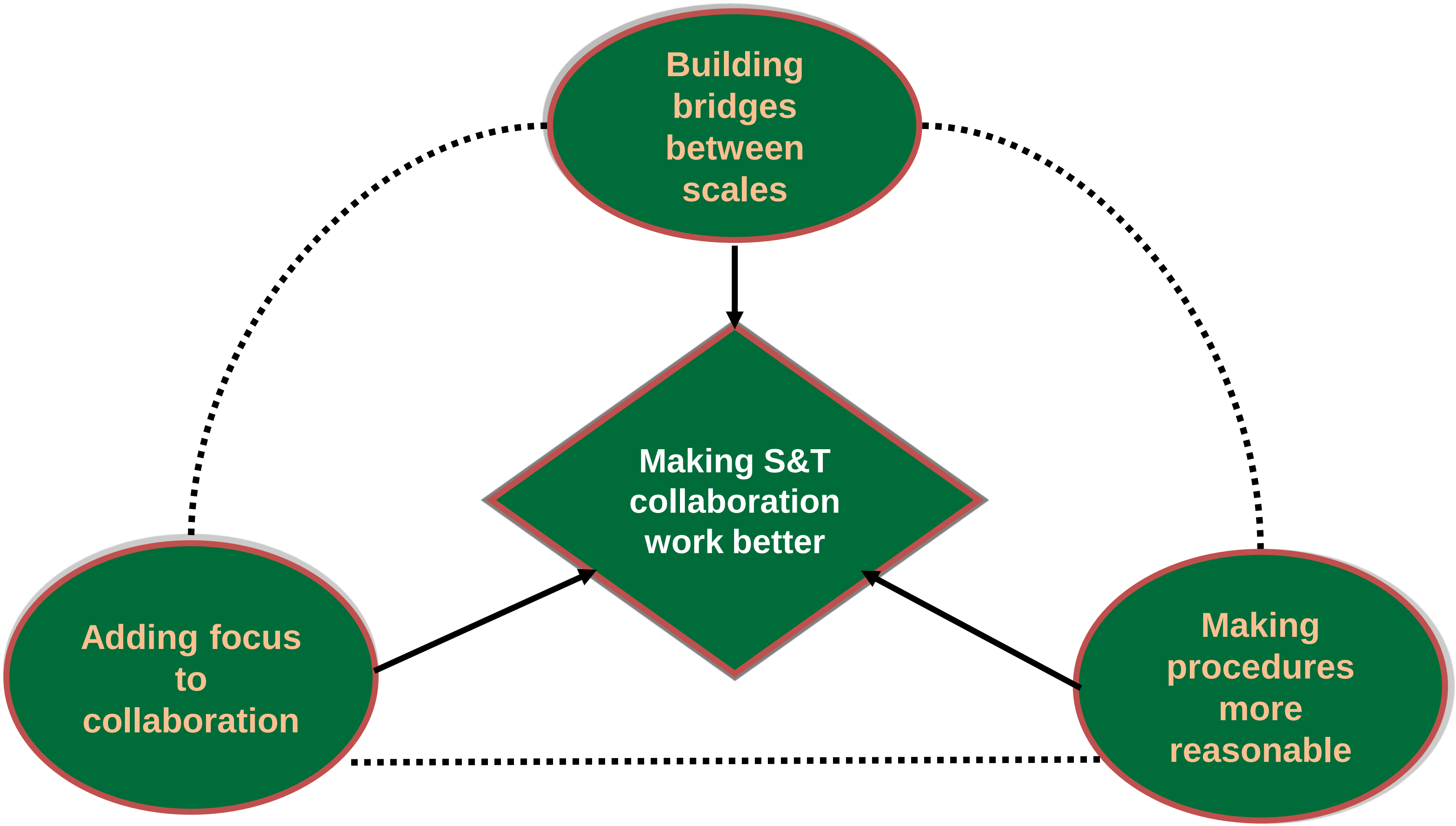
An Illustration of How Scale Matters:



Sustainability Science Is Associated with a Distinctive View of the Challenge Both to Knowledge and to Action (II):

- Priorities for <u>research</u> include integrative, place-based, interdisciplinary science focused on threats and pathways, attention to critical loads and carrying capacities, understanding and monitoring transitions, improving the understanding of consumption behavior, and developing incentives for technological innovation -- *increasing the focus on "usable knowledge,"* e.g.:
  - Linking research programs to societal goals
  - Improving linkages between knowledge development and sustainability problem-solving
- For example, an NAS Sackler Symposium on Linking Knowledge with Action for Sustainable Development, April 2008

Toward Strategies for Multiscale Collaboration:



Sustainability Science Is Associated with a Distinctive View of the Challenge Both to Knowledge and to Action (III):

- **Also priorities for <u>action</u>, such as accelerating current trends in fertility reduction; accommodating an expected doubling or tripling of the world's urban population; reversing declining trends in agricultural production in Africa and sustaining historic trends elsewhere; <u>accelerating improvements in the sustainability of energy and materials use</u>; and restoring degraded ecosystems while conserving biodiversity elsewhere**

Relating Sustainable Development and Energy Involves Two Related Concerns:

- **The sustainability of energy supply and use trajectories themselves:**
  - **Dimensions from a societal point of view:**
    - **Adequacy/abundance of services**
    - **Reliability of services**
    - **Affordability of services**
  - **Dimensions from a system design point of view:**
    - **Sustainability of resource supplies**
    - **Social consensus about acceptability**
    - **Effective production and delivery infrastructures**
    - **Effective science and technology infrastructures for innovation and problem-solving**

Relating Sustainable Development and Energy includes Two Related Concerns:

- **Relationships between energy trajectories and development goals and pathways:**
  - **Goals of energy policies for development (WDR, 2010):**
    - **Sustainable economic growth**
    - **Increased energy access**
    - **Enhanced energy security**
    - **Improved environmental management**
  - **To which sustainability science would add such sociopolitical dimensions as:**
    - **Equity in system management and performance**
    - **Broad-based participation in energy-for-development planning and problem-solving**

Issues that Seem to Need Particular Attention Include:

- **The path of global energy demand and supply**
- **The elusiveness of social consensus about desirable/acceptable energy trajectories**
- **The place of technology innovation and development**
- **How energy infrastructure transitions work**

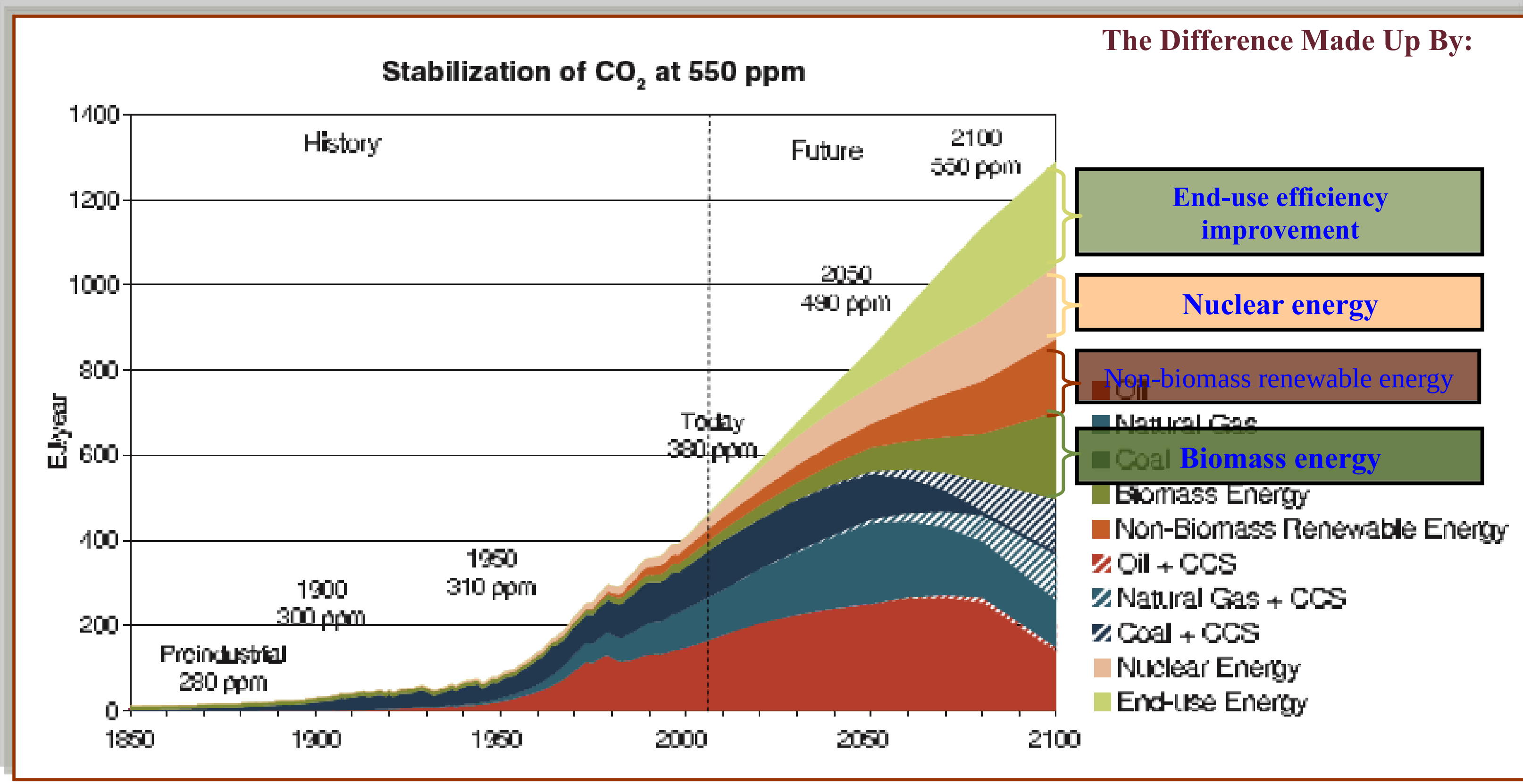
Regarding the Path of Global Energy Demand and Supply (I):

- The Asian dilemma: global GHG emission growth increasingly driven by China and India, but fossil energy is a key to their development
- Both expected to more than double their energy use between 2004 and 2030 – from 10% of world energy consumption in 1990 to 25% in 2030 (only 40 years)
- Domestic coal projected to supply 80% of electricity in China and 70% in India in 2030

Regarding the Path of Global Energy Demand and Supply (II):

- **Realistic alternatives are difficult to find, but they may include:**
  - **Pushing efficiency improvement and natural gas use in place of coal (but foreign policy implications of possible energy dependence on Russia?)**
  - **Accelerating innovative energy technological change – and demonstrations by industrialized countries: e.g., carbon capture and storage (but time lag)**
  - **Encouraging development <u>incentives</u> for accelerated technology shifts through partnerships with the region, e.g.:**
    - **Partnerships, including sharing of intellectual property (IPR obstacles)**
    - **Market incentives for Asian technology leadership (China and solar energy?)**

What Does This Imply For Energy Policy And Technology -- Technology Uses To Stabilize At 550 ppm?



Regarding the Path of Global Energy Demand and Supply (III):

- **Other issues include:**
  - **Oil peaking: a crisis for alternative energy sources sooner rather than later?**
  - **Prospects for technology breakthroughs (a topic to come…)**

Regarding the Elusiveness of Social Consensus:

- **Depends not only on characteristics of energy resource and conversion systems but also on the level of societal trust in responsible institutions**
- **Particular questions about energy alternatives viewed by society as "risky" (ORNL Report, 2009: *Generic Lessons Learned about Societal Responses to Emerging Technologies Perceived as Involving Risks*, with particular attention to possible concerns about bioenergy technologies associated with genetic engineering)**
- **Consensus may be enhanced by participative consultation at an early stage: e.g., the Asilomar Conference in 1975 to discuss safety issues raised by DNA manipulation: led to NIH guidelines that defused most major concerns**
- **Raises questions about prospects for energy sustainability unless new energy technologies can be developed or social values change**

Regarding the Place of Technology Innovation and Development (I):

- **Accelerating technological change as an essential part of the answer: a need for transformational innovation**
  - **A recent analysis at ORNL concluded that meeting U.S. goals of both climate protection and energy security requires a high probability of success for <u>all</u> 11 energy technologies considered – a long shot at best: Greene et al., *Energy Policy*, 2010**
  - **In fact, there is a growing sense of urgency about "transformational" energy technological change – not eventually, but soon: some calls for national commitments comparable to the Apollo mission to the moon or the Manhattan project**
  - **The issue is how to induce <u>discoveries</u>, not just incremental changes: e.g, the role of DARPA in the IT revolution – ARPA-E???: Wilbanks, *Energy Economics*, forthcoming 2011**

Regarding the Place of Technology Innovation and Development (II):

- **Accelerating technological change as an essential part of the answer: broadening global engagement in the search**
  - **Chances of a technology breakthrough are greater if we can reach and mobilize the best talent globally in the discovery process**
  - **This requires transferring to them what current science and technology knows and does, to be integrated with local knowledge to stimulate distributed discovery and innovation**
  - **The information technology revolution can be a powerful enabler of access to S&T knowledge, if intellectual property rights obstacles can be overcome: Wilbanks and Wilbanks, *Sustainability*, 2010**

Regarding the Place of Technology Innovation and Development (III):

- **Accelerating technological change as an essential part of the answer: focusing on critical path constraints, e.g.**
  - **The focus of DOE's bioenergy centers on liquid fuels from non-food bioenergy sources**
  - **The disposal of nuclear wastes (and now increased plant safety concerns related to Japan's earthquake damages)**
  - **Permitting processes for carbon sequestration sites**

Issues Regarding How Energy Infrastructure Transitions Work:

- Understanding not only where we want to get with our energy technology options but also understanding how to get there, which shapes the rate and level of market penetrations
- Transitions are nearly always impeded by the inertia of systems already in place, along with vested interests
- Often understudied:
  - Undermined early efforts to deploy solar energy technologies in developing countries such as Mexico
  - Lessons being learned from such recent experiments as the accelerated introduction of CNG vehicles into the public vehicle fleet in New Delhi, India
  - Often enhanced by commitments of government to assure (sometimes to be) markets for emerging transformational technology/resource alternatives
- Usually benefit from wide-ranging stakeholder consultations in order to shape partnerships and explore possible social concerns

In Summary:

- "Sustainability" is an established scientific quasi-discipline, with knowledge bases and centers of excellence
- Efforts to consider energy sustainability are likely to be enhanced by tapping into this body of research and experience and interacting with it
- We have avenues here at ORNL to help build such bridges -- especially when sustainability science has from the outset been concerned about energy sustainability in general and technology-related issues in particular

THANK YOU !

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